ECOLOGY

Ecology:

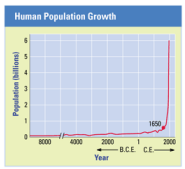
the study of the interactions between organisms and the living (**biotic**) and non living (**abiotic**) components of their environment

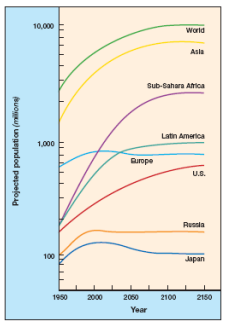
- field named in 1866

Impacts on the Environment

1. **exploding human population**

-requires increasing amts. of energy, food, and waste disposal space from earths resources

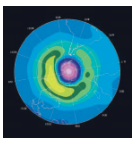




World Population Growth Patterns

Impacts, cont.

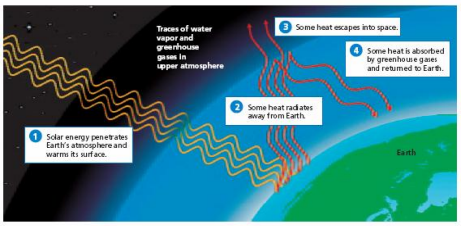
2. **sixth mass extinction**
   - habitat destruction, over-hunting, global warming, disease and predator introduction
   - last mass extinction: dinosaurs
3. **thinning of ozone layer**
   - due to chloro-flourocarbons CFCs
   - increases skin cancers

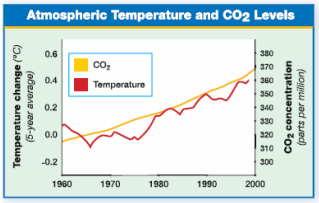


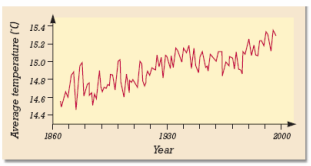
Thinning of Ozone over Antarctica

Impacts, cont.

4. **climate changes**
   - **greenhouse effect**: trapping of CO2 in atmosphere which prevents Earth's cooling
   - causes climate changes, rising sea levels, extinction





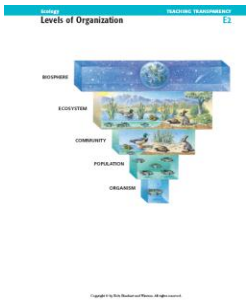


Levels of Organization

1. **Biosphere**: thin volume of Earth and its atmosphere that supports life

   13 mi thick
   (5-6 mi. above Earth to deepest oceans)

   Thin film of life covering a lifeless planet



2. **Ecosystems**: all living organisms and non living environment found in a particular place

   Organisms interact to affect survival.

   Ex: pond ecosystem:
   - Insects and fish eat aquatic plants
   - Turtles eat fish
   - Amt. of dissolved O2, CO2, pH, sunlight affects organisms that live in ecosystem

3. **Communities, Populations, Organisms**

Community: all interacting organisms living an area
Ex: all fish, turtles, plants, algae, bacteria, etc.

Population: all members of species that live in one place at one time

Organism: simplest level of organization

ALL ORGANISMS IN AN ECOSYSTEM ARE **INTERDEPENDENT** UPON THE BIOTIC AS WELL AS ABIOTIC COMPONENTS OF SYSTEM.

Ecology of Organisms

The environment affects the distribution of organisms and how organisms respond to their environments.

Habitat: place where organisms lives

Niche: role or job a species plays in its environment

Factors Affecting Organisms

A. Survival Factors

1. **Biotic factors**: all **living** components that affect organisms

2. **Abiotic factors**: **nonliving** physical and chemical characteristics

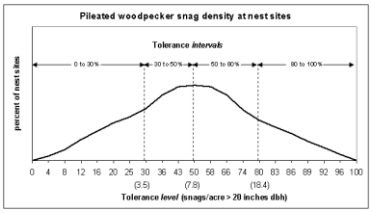
temperature	humidity
salinity	O_2 conc.
sunlight	amt. nitrogen
pH	amt. precipitation

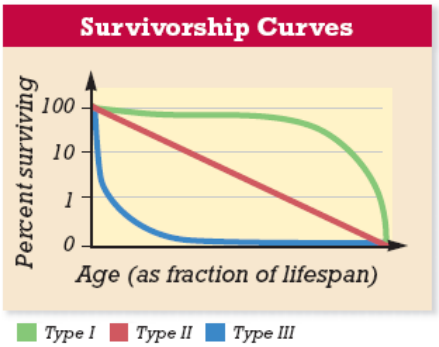
*** temp. change one of most important factors ***

3. **Biological Tolerances**

Tolerance curve: graph of performance versus environmental variable

- organisms can't live outside their tolerance limits (sometimes just one or more factors)





4. **Acclimation**: ability of an organism to adjust their tolerance to abiotic factors

ex: ability of organisms to adapt to life at high sea levels (increase in RBC)

Difference between acclimation and adaptation

- **acclimation** occurs within lifetime of organism
- **adaptation** is a genetic change in a species that occurs over many generations

5. **Ability to control internal conditions**

Conformers: do not regulate their internal conditions, they change as their external environment changes

ex: lizards, snakes

Regulators: use energy to control some of their internal conditions over a wide variety of environmental conditions

ex: mammals: body temperature
pacific salmon: control salt conc. in their bodies

6. **Ability to escape unsuitable conditions**

Dormancy: long term state of reduced activity during unfavorable environmental conditions

ex: bears hibernate
reptiles, amphibians: hide underground

Migration: move to a more favorable habitat

ex: birds

7. **Availability of resources**

Resources: energy and materials a species needs (varies from species to species)

ex: food, energy, nesting sites, water, sunlight, etc.

B. **Niche**: "way of life", role an organism plays in its habitat

Includes:

- Range of conditions species can tolerate
- Methods of obtaining needed resources
- Number of offspring
- Time of reproduction
- All other interactions with environment

Types of Niches

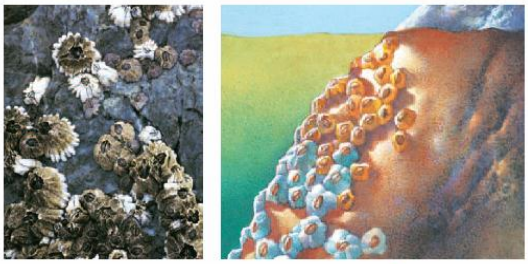
Fundamental niche: range of conditions that species can potentially tolerate and range of resources it can potentially use

- species may have to restrict activity of avoid predators
- competition may prevent it from using a resource

Realized niche: range of resources a species uses

- much narrower range than fundamental

Niche Types



The realized niche of *Chthamalus* is smaller than its fundamental niche because of competition from the faster-growing *Semibalanus*.

Niche Differences

Generalists: species with broad niches, can tolerate large range of conditions and resources

ex: Virginia opossum- feeds on anything

Specialists: species have narrow niches

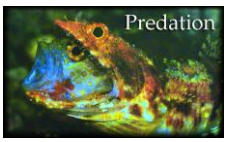
ex: panda- eats only eucalyptus trees

COMMUNITY ECOLOGY

The nature of a community is determined by the interactions (**symbioses**) of the populations that inhabit it.

Major Types of Symbioses

1. **Predation**:
   - powerful force that regulates population size
   - influences where and how species lives by relationship in the food web
   - predator captures, kills, and consumes prey
   - natural selection**:** favors adaptations of predators to kill prey **and** avoid being captured



ex: rattlesnakes- acute sense of smell and heat sensitive pits allow it to find prey even in dark

spiders: webs
tiger's coat: camouflage

Predation defense mechanisms

a. Mimicry:
- harmless species resembles poisonous or distasteful sp.
- two poisonous or distasteful species look alike



b. Plant/herbivore interactions:
- plants develop adaptations to prevent being eaten

- **physical defenses**: sharp thorns, tough leaves, spines, etc.

- **secondary compounds**: poisonous, irritating, bad tasting

ex: poison ivy, oak


Types Symbioses, cont.

2. **Parasitism**: species interaction where one individual is harmed and one benefits
   - parasite feeds on host
   - does not immediately cause death of prey
   - have adaptations to efficiently exploit host

two types

ectoparasites: external, live on host not inside

ex: fleas, lice , leeches, mosquitoes

endoparasites: internal

ex: bacteria, protists, worms

Types Symbioses, cont.

3. **Competition**: results from niche overlap with one or more species (one species more efficient at using resources than another species)

competitive exclusion: condition where one species is eliminated from a community because of competition for the same limited resource
- one species uses resources more efficiently and has reproductive advantage, eventually eliminating the other species

ex: kudzu

ex: Asian bighead carp

Competition, cont.

competition reduction: competition between species is reduced

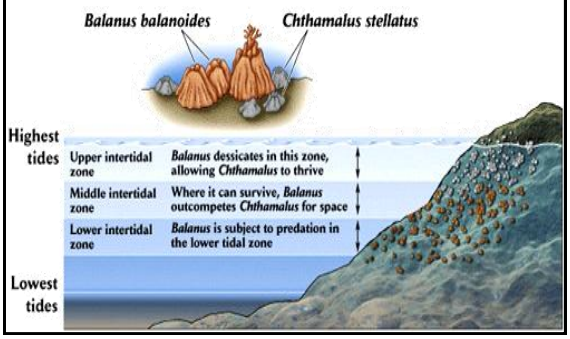
- **character displacement**: natural selection favors differences between potential competitors

  ex: different finch beak sizes

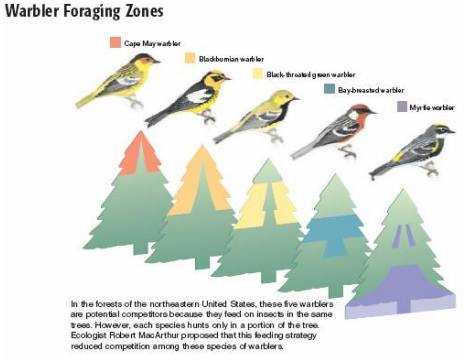
- **resource partitioning**: each species only uses one part of available resources

  ex: warblers hunt in different tree sections

Competitive Exclusion



Resource Partitioning



Types Symbioses, cont.

4. Mutualism and Commensalism

Mutualism: cooperative relationship where both species benefit (sometimes one can't live without other)

ex: pollination

Commmensalism: one species benefits and other is not affected

ex: sailfish on sharks

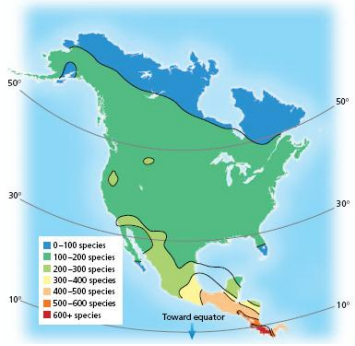
Properties of Communities

- Characteristics
  - **species richness**: total number of different species
  - **species diversity**: number of species : relative abundance of each species (how common each species is in the community)

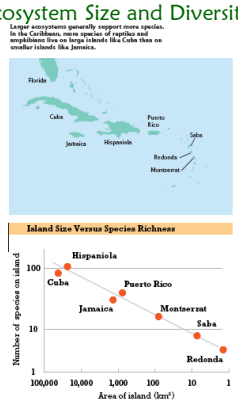
Properties of Communities, cont.

- Patterns of species richness
  1. **Latitude**: closer to equator = more species
     ex: tropical rain forests contain most variety of species (stable environment, year round photosynthesis)
  2. **Species- area effect**: larger area = more species
     - areas limited by geography can't support as many species (islands)
     - IMPORTANT CONSEQUENCE: reducing size of habitat, reduces number of species

Latitude and Species Richness



Ecosystem Size and Diversity



Properties of Communities, cont.

3. **Species interactions:** can promote species richness

   ex: one species can keep competition at bay with other species allowing more overall species to co-exist

   ex: certain starfish keep mussels from overpopulating a community and wiping out other species

4. **Community stability**: resistance to change

   - directly related to species richness:
     species richness improves a community's stability

Succession

- major environmental events trigger a sequence of changes that over time cause a change in the composition of a community

  ex: fires, landslides, earthquakes, volcanoes, floods

- some species flourish immediately, are then replaced by others, which are replaced by still others

Succession
the gradual sequential re-growth of species in an area

Types of Succession

Primary: development of a community in an area that has **not previously supported life**

- slow progression because minerals necessary for growth are unavailable

  ex: bare rock, sand dune, volcanic island

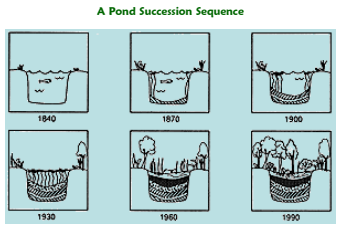
Secondary: sequential replacement of a species following disruption of an existing community

- usually quicker because soil has been left intact
- more likely result of disturbance (agriculture, urban sprawl, etc)

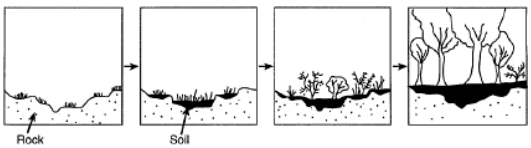
Succession, cont.

Pioneer species: small fast growing and reproducing species well suited for invading and occupying a disturbed habitat

Climax community: stable end point in a community after a series of predictable stages have occurred

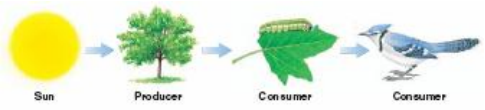


A Typical New York State Succession



Stage	Dominant Flora
A	None (freshly plowed land)
B	Annual grasses
C	Various shrubs
D	Birch and cherry trees
E	Beech-maple forest

ECOSYSTEMS AND THE BIOSPHERE



Energy Transfer

- all organisms need energy to carry out essential functions of life
- energy is transferred from the sun to autotrophs to heterotrophs, etc
- energy transfer within the ecosystem has an important impact on the ecosystem's structure

Energy Transfer

- **Producers**
  - autotrophs (bacteria, protists, plants)
  - add **biomass** (organic material) to ecosystem
  - photosynthesis: terrestrial ecosystems- plants
  - chemisynthesis: acquatic ecosystems: bacteria/protists

Measuring productivity of producers:

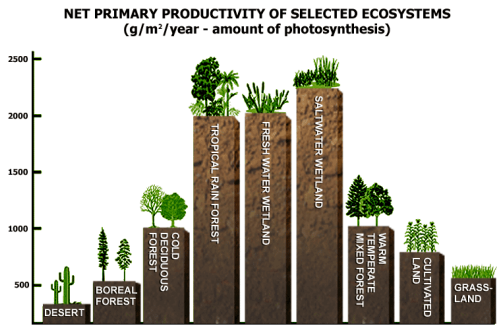
* certain ecosystems produce a lot more energy than others*

ex: rainforests only 5% earth, produce 30% NPP

- productivity affected by:

aquatic ecosystems: light, availability of nutrients
terrestrial ecosystems: light, temp, precipitation

COMPARATIVE PRODUCTIVITY OF ECOSYSTEMS



- **Consumers**
  - **heterotrophs:** bacteria, protists, all fungi, animals
    - **herbivores**: eat producers (plants)
    - **carnivores**: eat consumers
    - **omnivores**: eat producers and consumers
    - **detritivores**: eat "garbage" of ecosystem (recently dead organisms, fallen leaves, animal wastes)

- **decomposers**: class of detrivores that causes decay by breaking down dead tissues and wastes into simpler molecules (bacteria,fungi, worms)

* make nutrients available to autotrophs*

Energy Flow

- energy is transferred as one organism eats another
- energy moves thru an ecosystem moving from producers to consumers
- scientists follow the transfer of energy by **trophic levels**

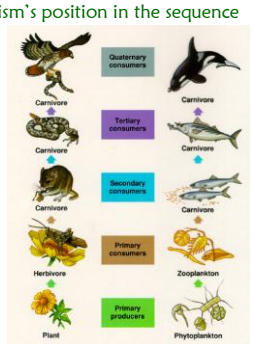
TROPHIC LEVELS

Trophic level: organism's position in the sequence of energy transfers

1st level
all producers

2nd level
herbivores

3rd level
predators of herbivores

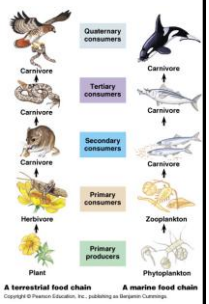


Feeding Relationships in Ecosystems

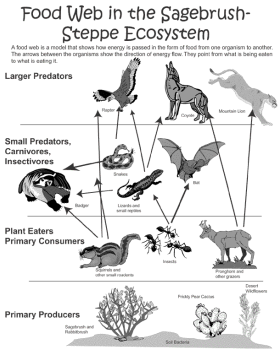
Food chains

- single pathway of feeding relationships of an ecosystem
- usually too complex to be represented by one food chain
- short food chain: low rate of energy transfer between trophic levels
- lower trophic levels have many more organisms than higher trophic levels

(less energy at higher levels, so supports fewer individuals)



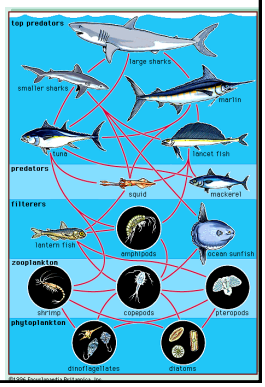
Food web: interrelated food chains in an ecosystem



Marine Food Web

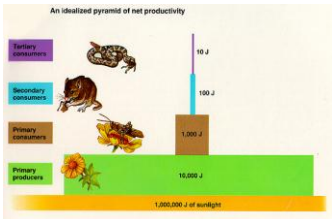
Plants, herbivores, and carnivores make up the food web.

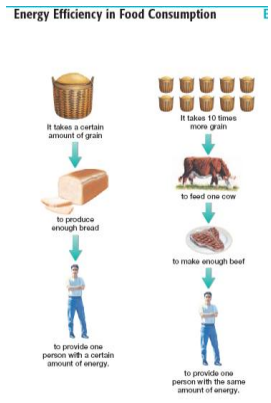
****Phytoplankton****
base of the ocean's food web



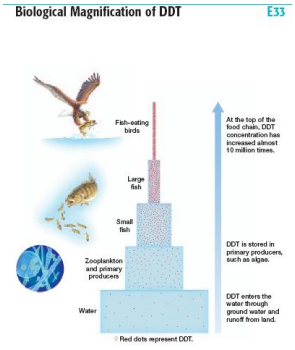
Quantity of Energy Transfers

- About **10%** of total energy consumed in one trophic level is incorporated into organisms of the next level
  - maintaining body temp, ability to move, and high reproductive rate require a lot of energy leaving less for higher levels
  - energy pyramids show the rate that each level stores energy as organic material





Biological Magnification



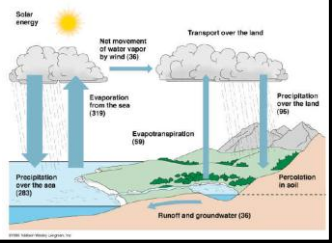
Substances become concentrated in tissues or internal organs as they move up the food chain

Ecosystem Recycling

Biogeochemical Cycle:
cyclical abiotic/ biotic pathway through which water and minerals pass in an ecosystem

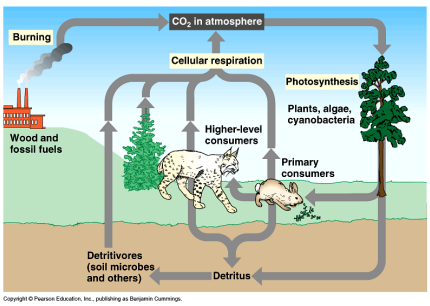
Water Cycle

- movement of water from reservoirs
- water availability is key factor that regulates productivity of terrestrial ecosystems
- water found in organisms, atmosphere, bodies of water, and below ground
- **ground water**: in soil or underground rock
- processes in water cycle
  a. **evaporation**
  b. **transpiration**
  c. **precipitation**



Carbon Cycle

cyclical relationship of photosynthesis and respiration

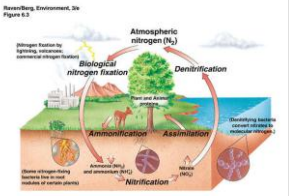


Nitrogen Cycle

-pathway of nitrogen through an ecosystem

-plants use nitrogen in form of **nitrates**

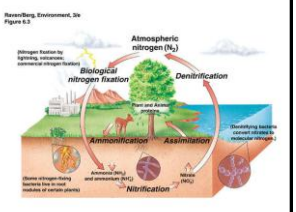
-**nitrogen fixation**: process of converting nitrogen gas to nitrate



-**nitrogen fixing bacteria**:
convert **N(g) → NH3 → nitrite (NO2) → nitrate (NO3)**

Nitrogen Recycling Process:

1. **ammonification**: process whereby decomposers break down waste products, urine, and corpses into nitrogen containing NH_4
2. **nitrification**: process whereby bacteria take up NH3 and oxidize it into nitrites (NO2), and nitrates (NO3)
3. **denitrification**: process whereby anaerobic bacteria break down nitrates and release N gas back into atmosphere
4. **animals must eat plants** to get their nitrogen



Study lots and lots and lots!!!

Food Chain Letter.